ENERGY UPDATE

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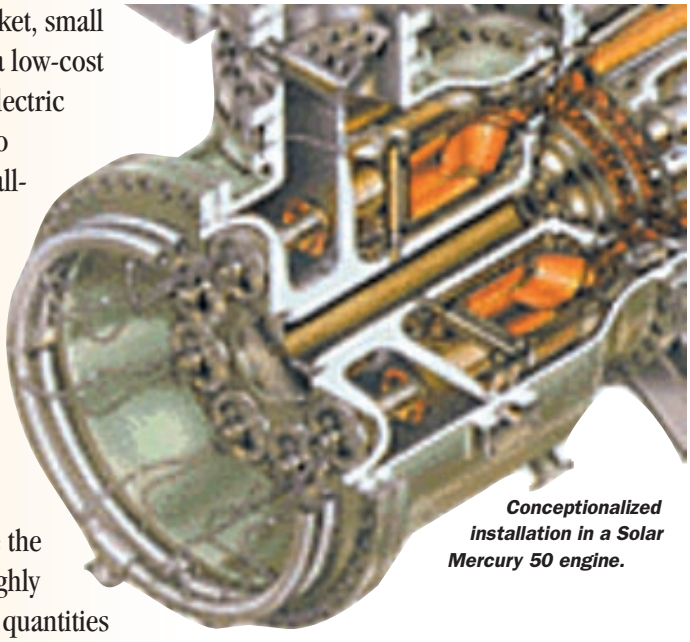
LOW EMISSIONS GAS TURBINES: CHEAPER ENERGY, CLEANER AIR

In California's electricity market, small gas turbine generators offer a low-cost and efficient source of new electric capacity. The major hurdle to broad implementation of small-scale gas turbines has been exhaust levels of nitrogen oxides (NO_x) that exceed levels permitted in many California air quality management districts.



Conceptionalized installation in a Solar Mercury 50 engine.

One method of reducing the formation of NO_x is to reduce the flame temperature by thoroughly premixing the fuel with large quantities of air prior to combustion. This is referred to as "lean pre-mixed" combustion. The problem with this approach is that the flame becomes unstable when the fuel is too diluted (lean) in the mixture. This can cause the flame to go out or can result in "flickering" (technically referred to as "combustor dynamics") that can cause severe physical damage to the combustor.

The California Energy Commission co-funded research at Alzeta Corporation of Santa Clara aimed at solving these problems. Under an $879,000 contract completed in April 1999 and backed up by earlier work co-funded by the Commission and others, Alzeta successfully demonstrated an approach to lean pre-mixed combustion for gas turbines that achieved both very low NO_x emissions and stable combustion.

Redefining Gas Turbines

Emissions from megawatt-scale gas turbines exceed the limits imposed by most California air quality districts and by many other air districts in the United States. The best NO_x performance by most commercially available gas turbines is around 15 parts per million (ppm). Some air quality management districts require a NO_x limit of 2 parts per million for new sources (at 15% O_2). In regions with the 2 ppm limit, new gas turbine installations require additional equipment to remove NO_x from the exhaust. These exhaust clean-up systems are expensive to build and operate, they penalize the fuel-to-electricity performance of the engine, and they introduce additional potential for unreliability in the overall system. Although utility-scale gas turbines justify the cost and complexity of exhaust clean up systems, gas turbines with a nominal size of 5 MW cannot. As a result, very few engines of this scale have been installed in California since the mid-1980s.

How They Work

The Gas Turbine Semi-Radiant Burner, or GTSB, is based on advancements in Alzeta's Pyromat metal fiber burner technology. Extensive laboratory and field-testing have shown the GTSB is durable in a broad range of operating conditions and environments at atmospheric pressure. These applications include a number of heater and boiler applications.

During recent tests at Alzeta, as well as at government and industrial lab facilities, Alzeta's GTSB combustors successfully demonstrated simultaneous readings below 2 ppm emissions of NOx, CO and unburned hydrocarbons under certain conditions. These emissions are several times lower than pollutant emissions from state-of-the-art gas turbines.

(Cont.)

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GTSB technology will expand the market for gas turbines by significantly reducing the cost of NO_x mitigation. It is anticipated that the GTSB system cost will be less than 10% of the cost for the standard combustion system and normally required exhaust clean-up systems.

Benefits to Consumers

"Our GTSB technology will expand the market for gas turbines and result in huge cost savings for California consumers," said Alzeta's Chairman of the Board, Bob Kendall. "This is because it provides power plant operators with a simple and cost-effective approach to meeting stringent air quality standards throughout the state."

While it takes time for innovative energy products to pay off in the marketplace, Alzeta has already sent the California Energy Commission its first royalty payment for the development of the Pyromat surface stabilized combustor, the technology that the GTSB is based upon.

"The technology, applicable to natural gas-fired turbine distributed generation systems in California, will enable efficient, flexible and cost-effective means of low emissions power generation to remain competitive in the face of increasingly stringent NOx regulations," noted Energy Commissioner Art Rosenfeld.

Small gas turbines are an ideal distributed energy resource. In California, such distributed resources are critical to enhance the reliability of the electricity grid and to prevent power outages. Toward this goal, the state through PIER is partnering with private enterprise to develop low- or no-emission electric generation technologies, including natural gas turbines, renewable resources and fuel cells, to help reduce air pollution and greenhouse gas emissions and increase energy and economic efficiency.

The PIER program is dedicated to improving the quality of life in California through the continued introduction of environmentally sound, safe, reliable and affordable energy services and products into the marketplace.

Alzeta's prototype GTSB is ready for testing

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